Utilization of a Ducted Wind Turbine in a Trailer Mounted Renewable Energy Micro-grid (TREM)

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TREM System for CERDEC

Goal of TREM

- First unit delivered to CERDEC in fall of 2010
- Focused on creating a 2 to 5kW system maximizing the wind resource
- Energy storage to eliminate renewable energy variability
- Customizable to maximize renewable resource at a given location

Overview of Initial System

- A mobile renewable power system platform utilizing a 4.5BT-500 Turbine as primary power source.
- First generation system leveraged commercial off the shelf components in conjunction with some required custom designed components which will allow for an efficient and economical initial solution.
- The target design of the system solution will be to provide a platform capable of accepting a wide range of voltages and therefore greater options with regards to power generation sources.

Trailer Components

- Power creation
  - Ducted Turbine
  - Solar PV
  - Generator / Grid
- Energy Storage
  - Initial Unit with 14kWh of VRLA
- Power Distribution
  - Multiple AC and DC outputs and voltages

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WindTamer Ducted Turbine

VIDEO

- To be included on CD at show

Patented Design

Patent: Fluid Driver Vacuum Enhanced Generator

- **Design uses the wind to induce rotation just as conventional wind mills**
- **Utilizes a sophisticated bypass system that harnesses one vacuum that forms internally behind the blades**
- **Second vacuum that forms externally to assist rotation**

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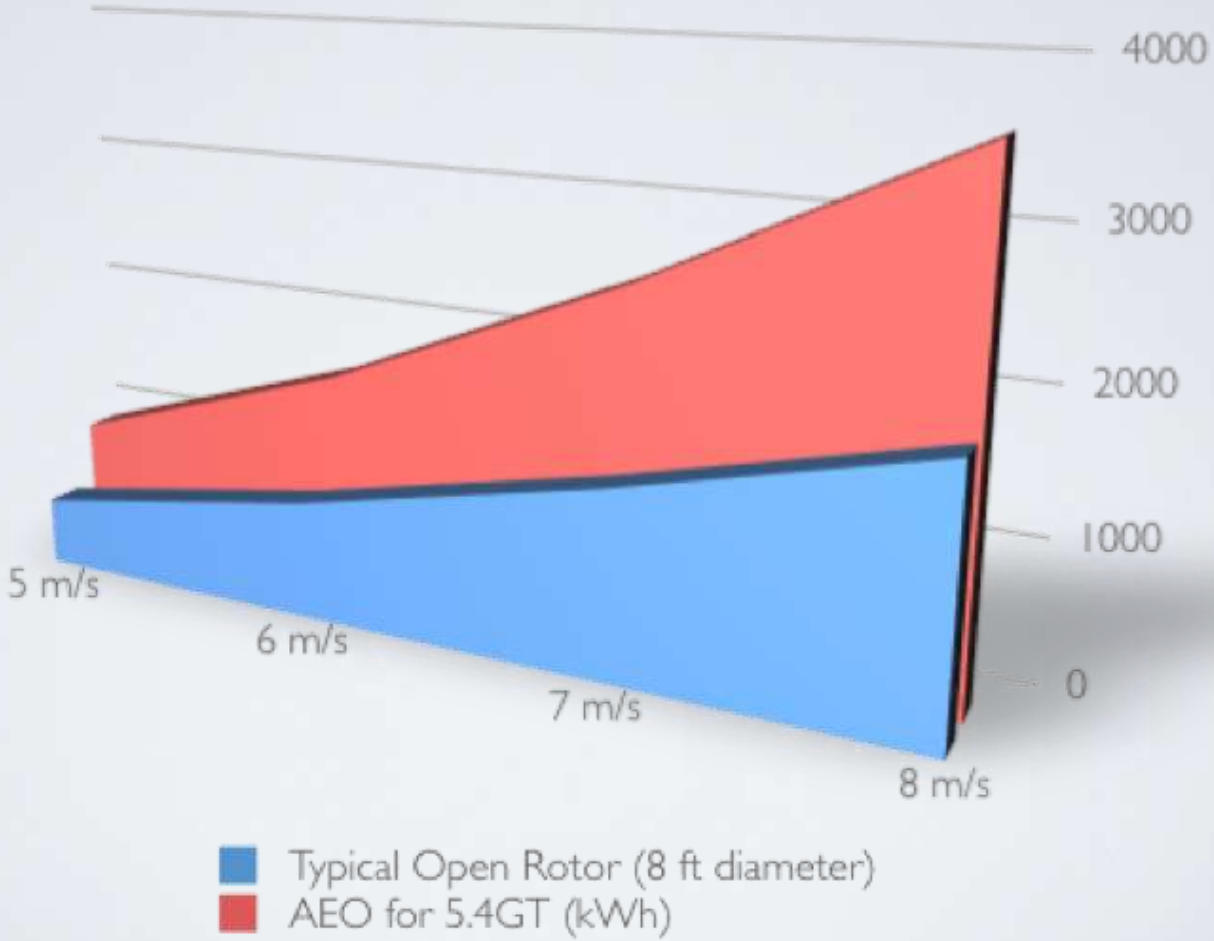
4.5GT AEO



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Advantages of Ducted Turbines

- Low Noise Operation
- Minimal maintenance – 2 moving parts
- Safety – No open spinning blades
  - There is no danger of blade throw or ice build up
- Enhanced efficiency of available wind power over open rotor systems
- Real-time monitoring and braking to insure system safety and maximum energy generation

Solar PV

- Wind and Solar are an excellent compliment
- Configurable to energy creation scaling
- Initial system utilized thin film solar PV
- More recent systems incorporate ruggedized monocrystalline panels for maximum efficiency.

Energy Storage and Power Distribution

- 16 Batteries PowerSonic VLRA: 14.2kWh total storage
- Designed Capacity of 7.2kWh: Limit VRLA to 50% to maximize cycle life
- Maximum AC Discharge of 2kW
- Maximum DC Discharge of 600W

Input Power

Source	Voltage	Rating
Wind Turbine	Variable: 0 to 55VDC	.40-.45 efficiency from available wind
Solar Panel	15VDC, 110 Watt	85%, 6hrs optimal light
AC	Shore Power (AC direct from utility source of generator)	120 VAC

Output power

Power Type	Max Power Rating	Current Rating	Connection Options
120 VAC	2000 watts	30 amps (2 15A breakers)	4 GFI outlets
12 VDC	300 watts (100 W ea. outlet)	10 amps each connector	3 Cig style outlets
28 VDC	300 watts	30 amps (fuse)	4 pin weather proof connector

Mechanical Overview

- System Mounted to 6'8" x 14' tandem axle trailer
  - Tube rail, wood deck, jack with autoleveling
- Custom and Pre-Fab Cabinets vented for battery, electronics and additional storage
- COTS Winch System
- Weight Distribution Balanced for towing and stability
- Interface Controls
  - Favor Driver side of trailer
  - Basic gauging + monitoring

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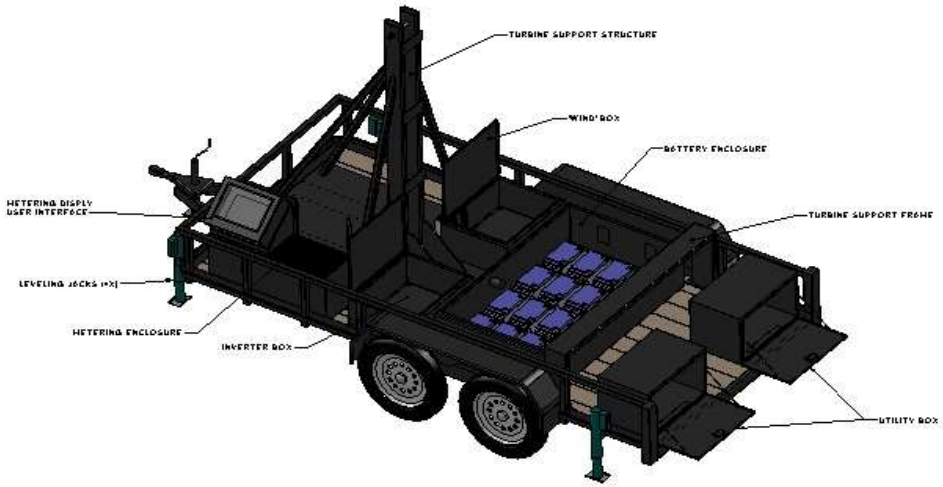
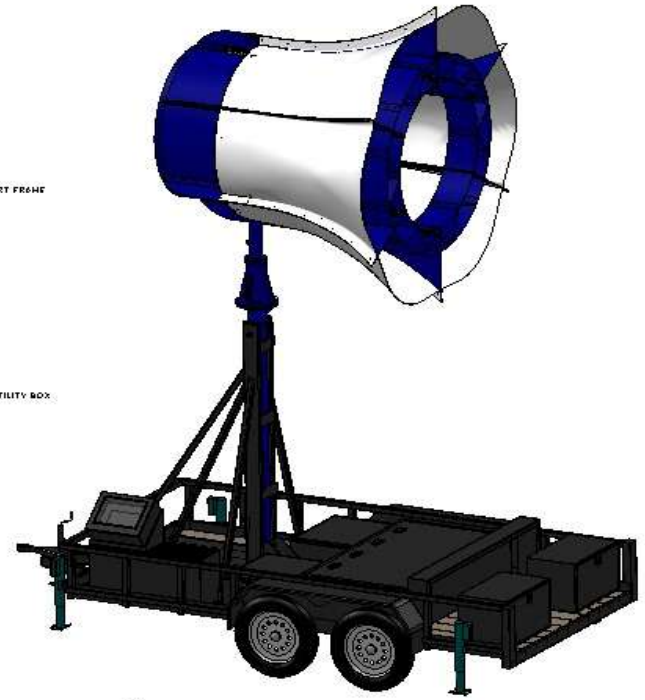
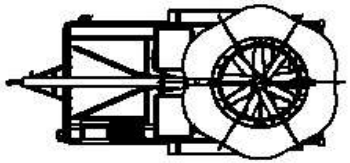
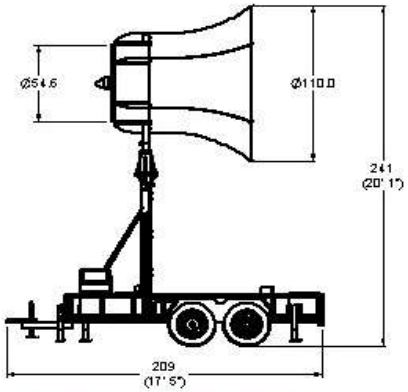
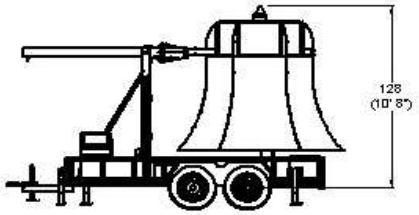




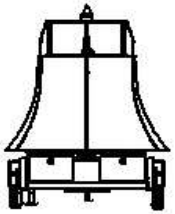




TEST UNIT IN RAISED (PARKED) POSITION



TEST UNIT IN LOWERED (TRAVEL) POSITION



Unit Validation

Charge Time based on Wind Speed (need 7kWh to charge 50% depleted battery)

Wind Speed (mph)	Solar (6 hr Raidiation)	Wind Output 24 Hours	Recharge Time from only renewables
12	75W/h	75W/h	81 hrs
16	75W/h	200W/h	30 hrs
20	75W/h	400W/h	16 hrs
24	75W/h	600W/h	11 hrs
28	75W/h	800W/h	8 hrs

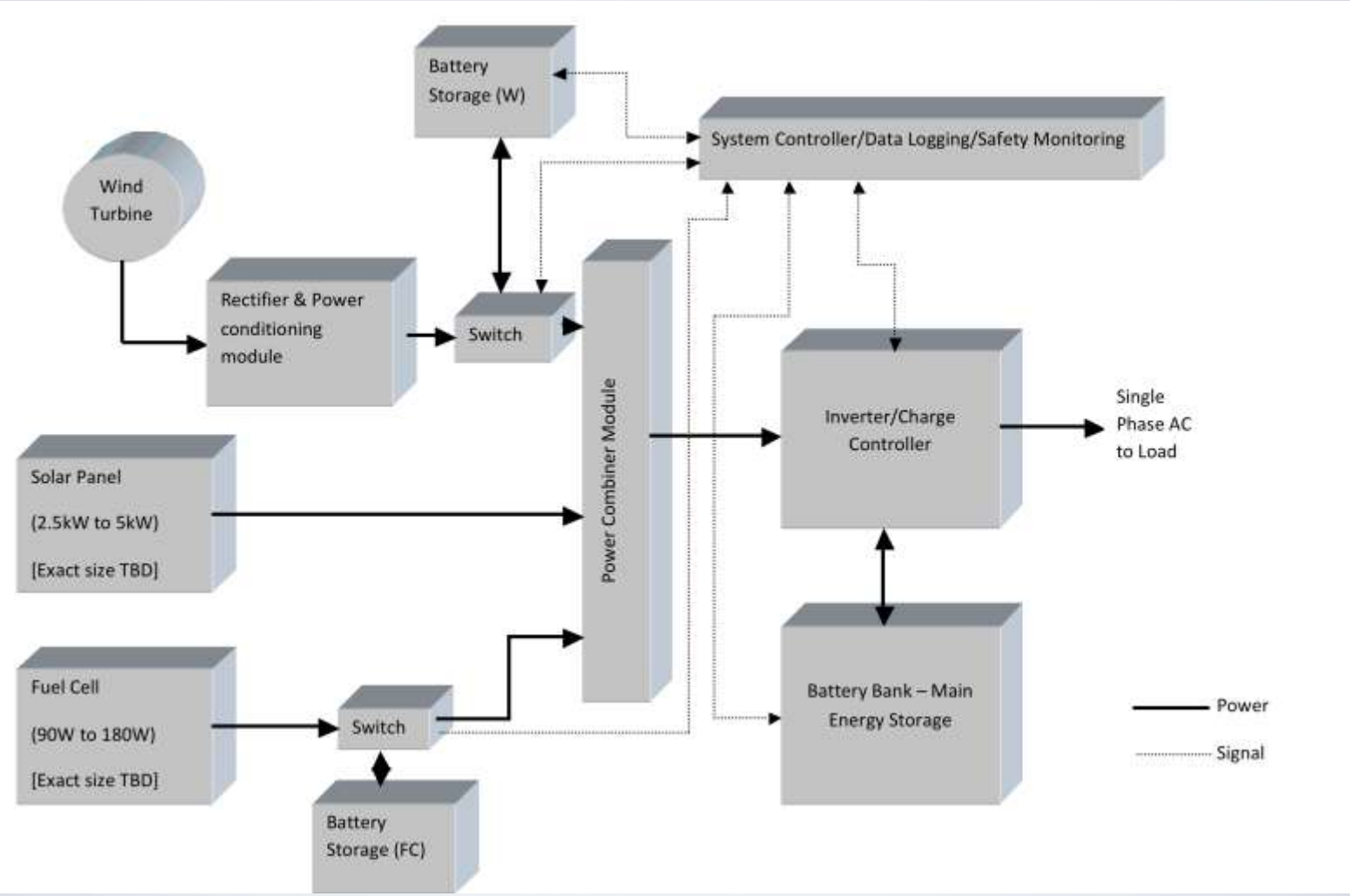
Testing of unit continues at Aberdeen Proving Grounds

Usage Savings versus Generator and JP8

- No requirements to provide logistic fuels (renewable energy)
  - Fewer people delivering fuel (cost and safety)
- 10kW Generator Uses 10 to 15 gallons of JP8 per day
- At $15 per gallon annual savings of $121,667 in JP8 alone

Future Iterations / Learning from Initial Build and Testing

Revised System Architecture



Energy Generation

- Wind Turbine
  - 5.4BT-500
  - Multiple micro-turbines 300 to 500 watts
  - Increase efficiency reduce duct size and weight
- Solar PV
  - Rapid deployable / ruggedized 230W to 250W panels
- Fuel Cell
  - Smart Fuel Cell EVOY PRO 2200 XT

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Energy Storage /Power Distribution

- Chemistry Agnostic based on system requirements
  - Lithium Ion, Lead-Acid and NiMH
  - Based on application requirement
    - Temperature
    - Cycle Life
    - Cost
    - Weight
- Power Distribution from 1kW to 1MW
- Scalable from Mobile Unit to Commercial Building

Mechanical / User Interface

- Ruggedization for each environment / applications
- Telescoping pole for various turbine heights
- Integration of remote monitoring capabilities
- Various Deployment Versions:
  - Permanent off trailer with parallel capabilities for larger installation
  - Rapid Deployment
  - Semi-mobile with larger solar array

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Thank You